Station Circular 68 February, 1926

Oregon Agricultural College

Experiment Station

Sprays, Their Mixing and the Compatibility of Various Combinations

By

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CORVALLIS, OREGON

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SUMMARY

Most sprays, and combinations of two or more spray materials, should be applied immediately after they have been mixed in the tank.

If combination sprays are not mixed properly, the chemical reactions may reduce the insecticidal or fungicidal value as well as cause injury to foliage and fruit.

The use of milk or casein spreader is advised with many combinations to retard chemical changes.

This circular recommends methods of mixing various sprays and combinations of spray materials, whereby injury from chemical reactions may be reduced to a minimum.

A table is given on pages 6 - 7 showing procedure for mixing sprays.

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Sprays, Their Mixing and the Compatibility of Various Mixtures

By

R. H. Robinson

The successful production of orchard and certain other farm crops depends to a large extent upon the control of insect pests and fungous diseases that infest them. It is important, therefore, to know what spray materials to use and how to prepare them to get best results.

When care is not exercised in the mixing of sprays, especially combinations of two or more materials, severe burning of the foliage and fruit may occur. Another factor that may influence the quality of the spray is the chemical reactions of combination sprays. The reaction products may be far less toxic than the materials used, or they may be soluble compounds that will burn the foliage and spot the fruit. The use of hard water likewise may cause harmful results. These difficulties may be avoided to a large extent if, first, some substance is added to the sprays to reduce chemical reactions in the spray tank and, second, a definite procedure is followed when mixing sprays in the tank for application.

In order that the difficulties attending the mixing of sprays may be avoided and best results possible may be obtained, recommendations are made for the procedure that should be followed for preparing the different sprays. These recommendations are based mainly upon laboratory studies of the chemical and physical reactions of the different combinations. The procedure that reduces the reaction to a minimum is advised.

MATERIALS USED TO REDUCE CHEMICAL REACTIONS IN COMBINATION SPRAYS

Investigations have shown that many substances may be used to retard chemical reactions of various combination sprays. Among these materials skim milk and commercial casein spreader have been found most practicable. It may be explained that the commercial casein spreader is prepared from skim milk. The casein in the milk is precipitated, dried, and mixed with three parts of hydrated lime. If, therefore, hydrated lime is added to skim milk, an equally good spreader will be obtained.

PROPORTIONS OF SKIM MILK OR CASEIN SPREADER TO BE USED

Either skim milk or commercial casein spreader may be used in the combination sprays to retard chemical reactions. When skim milk is used, two quarts should be added for each 100 gallons of spray. About ½ pound of hydrated lime (or ½ pound quick-lime, well slaked) must be added to each gallon of milk before it is used. Other milk products, such as dried skim milk or sour milk may also be used. Lime also must be added to these materials before using.

Procedure and Time to Add Various Spray Materials or Combinations of Spray Materials to the Spray Tank

Spray materials and combinations	When tank is ½ full	When tank is ¾ full	In orchard just before beginning to spray
Lead arsenate			Add lead arsenate
Lime-sulfur, liquid or dry, self-boiled lime-sulfur, Oregon cold-mix lime-sulfur or other sulfur spray	Add any time		
Bordeaux—prepare home-made mixture	Add required amount of slaked quick-lime or hydrated lime	Start agitator and run in diluted copper sulfate solution.	Spray immediately after preparation.
Nicotine sulfate		Add milk + lime or casein spreader followed by nicotine sulfate.	
Miscible oils or "cold prepared" oil emulsions	Dilute oil with equal amount of water, mix well, and add slowly to spray tank at ¾-full mark		
Combination— Lead arsenate and lime-sulfur or other sulfur sprays.	Add lime-sulfur or other sulfur sprays	Add milk + lime or casein spreader	Add lead arsenate
Combination— Lead arsenate and sulfur sprays and nicotine sulfate	Add nicotine sulfate	Add milk + lime or casein spreader *followed by* lime-sulfur or other sulfur spray.	Add lead arsenate

Combination— **Lead arsenate and nicotine sulfate**	Add nicotine sulfate	Add milk + lime or casein spreader	Add lead arsenate
Combination— **Nicotine sulfate and lime-sulfur or any other sulfur spray**	Add nicotine sulfate	Add milk + lime or casein spreader	Add lime-sulfur slowly just before tank is full
Combination— **Bordeaux (home-made) and oil emulsions**	Add required amount of slaked quick-lime or good hydrated lime	Add very dilute copper sulfate solution	Add oil, mixed with equal volume of water just before tank is full.
Combination— **Bordeaux (home-made) and lead arsenate**	Add required amount of slaked quick-lime or good hydrated lime	Add very dilute copper sulfate solution	Add lead arsenate just before beginning to spray.
Combination— **Oil emulsion and lead arsenate**	Add lead arsenate followed by oil emulsion just before tank is full		
Combination— **Bordeaux (home-made) and nicotine sulfate**	Add required amount of slaked quick-lime or good hydrated lime	Add very dilute copper sulfate solution	Add nicotine sulfate mixed with a gallon of water.
Combination— **Bordeaux (home-made) and nicotine sulfate and lead arsenate**	Add required amount of slaked quick-lime or good hydrated lime	Add very dilute copper sulfate solution followed by nicotine sulfate mixed with a gallon of water	Add lead arsenate just before beginning to spray.
Combination— **Bordeaux and lime-sulfur**	This combination SHOULD NOT BE USED		

Notes and explanations

"Milk + lime" means ½ pound lime (hydrated lime or quick-lime, well slaked) mixed in 2 quarts skim milk for each 100 gallons of spray.

"Casein spreader" refers to any of the commercial casein spreaders—to be used at the rate of ½ pound to 100 gallons of spray.

"Copper sulfate" is often called "bluestone" or "blue vitriol."

"Nicotine sulfate" is the commercial "Black Leaf 40," "Hall 40% Nicotine," or other brands.

If the orchardist desires to use commercial casein spreader instead of skim milk, ½ pound to each 100 gallons of spray should be added. This amount is not recommended for spreading purposes, but to retard chemical action in certain combination sprays.

CASEIN SPREADER OR SKIM MILK FOR SPREADING PURPOSES

The Experiment Station has not given any definite recommendations regarding the use of casein spreader for spreading purposes only. Many factors influence its practicability. The orchardist is best able perhaps to know whether, under his particular conditions, it is advisable to go to the added expense of using spreader. The cost, severity of disease or insect infestation, spray used, time sprayed, climatic conditions, and other factors must be considered. If the orchardist finds it desirable to use the casein for spreading purposes, the skim milk should be used if available. This substitute will reduce costs more than a half and be equally effective.

When used for spreading purposes a larger amount of skim milk or casein spreader should be added than is recommended to retard chemical action in combination sprays. Three quarts of skim milk or ¾ pound of the commercial casein spreader to each 100 gallons of spray is sufficient for most sprays. As noted above, ½ pound of hydrated lime should be added to each gallon of milk used. If sweet skim milk is not available sour milk may be used.

MIXING OF ONE SPRAY ONLY

When one spray material only is to be used the principal precaution to take is to apply the spray immediately after mixing a tank full and not let it stand before using. If the orchardist desires to use milk or the commercial casein as a spreader it should be added after the tank is about three-fourths filled with water. This is advisable on account of the excess foaming that occurs if the spreader is added sooner. The time for adding the various materials and precautions that should be taken are given under the following heads.

Lead arsenate. When lead arsenate is used alone it may be added to the spray tank at any time during the filling process. Since it is very important, however, to add the lead arsenate last in combination sprays, it may be set down as a general rule that *"lead arsenate should be added to the tank in the orchard just before starting to spray."* By following this procedure the time for solubility and chemical reaction is diminished to a minimum.

Lime-sulfur (liquid or dry); Oregon cold mix; self-boiled lime-sulfur; other sulfur sprays. These spray materials may be added to the tank any time during the filling process.

Bordeaux mixture. The home prepared product only is advised since the commercial paste or powder bordeaux mixture will not adhere sufficiently long to give as satisfactory results as the home-made material. Methods and precautions for the preparation of home-made bordeaux are given in Oregon Experiment Station Bulletin 201.

To mix bordeaux for immediate application the required amount of slaked quick-lime (or fresh hydrated lime) is added before the tank is half full. After the water reaches about the three-fourths full mark, the dilute copper sulfate is added slowly with the agitator going. This spray should be applied immediately, since it soon begins to change to the crystalline form which will not adhere well.

If it is necessary to let a tank of spray stand around, even for two hours, a little sugar should be added to prevent changing to the crystalline state. About one ounce of sugar to 100 gallons will suffice. This should be dissolved in a little water and added with the lime, although fair results will be obtained even if added after the mixture is made.

Nicotine sulfate. The effectiveness of nicotine sprays depends in a large measure upon contact with the insect and subsequent volatility. It is important, therefore, to use milk or casein spreader with this spray. This treatment will increase contact by wetting and the lime present will increase the volatility of the nicotine.

To prepare this spray proceed as follows: The tank is first filled about three-fourths full and the skim milk or commercial spreader is added. An extra pound of good hydrated lime or slaked quick-lime is then added. The required amount of nicotine is diluted with a gallon or more of water and then added to the spray tank.

Soap may be used advantageously in nicotine sprays for spreading purposes on garden crops, hops, and for certain other plants, but the milk or casein spreader only should be used for orchard work. If soap is used in orchard spraying any time after the buds open, severe injury may occur, especially if sprayed with lead arsenate.

Oil emulsion and miscible oils. All types of oil sprays should be diluted with an equal amount of water and well mixed before adding to the spray tank. This reduces a tendency of the oil to separate out. The tank is filled with water, about three-fourths full, and the diluted oil spray added. The agitator should be going as the oil is slowly poured into the tank. It is best to apply immediately after a tank full has been mixed, as the oil may have a tendency to rise to the surface and separate out.

COMBINATION SPRAYS

It is in the combination sprays that more than ordinary care should be exercised during the mixing process. Procedures are given below for most combinations that may be used in Oregon. The table given on pages 6-7 should be studied, and the order of adding the various materials to the spray tank should be followed carefully. Where milk or casein spreader is advised, it is for the purpose of retarding chemical action and not for spreading effects.

Lime-sulfur (or other sulfur spray)—lead arsenate. In all combination sprays where lead arsenate is one of the materials used, milk or casein spreader should be added to retard chemical action. When the tank is three-fourths full the lime-sulfur or other sulfur spray may be added, followed by the milk or casein spreader. Immediately before starting operation in the orchard, the lead arsenate is sifted into the tank.

A tank of this combination should be sprayed as soon as the lead arsenate is added. Although the milk or casein spreader retards the chemical action, enough may occur in several hours to diminish somewhat the toxicity of the combination and to cause burning of foliage.

Nicotine sulfate—lead arsenate. As previously stated, it is important to use milk or casein spreader with all sprays containing nicotine. The addition of an extra pound of lime per 100 gallons also is well worth while.

To mix this combination the nicotine sulfate is added to the tank any time before the water reaches the three-fourths full mark. The milk and an extra pound of lime are then added. Finally just before starting to spray, the lead arsenate is sifted into the tank.

Nicotine sulfate—lime-sulfur—lead arsenate. This three-spray combination is often used in Oregon, and for best results the order of adding these materials should be followed closely. When the water reaches the three-fourths full mark the nicotine sulfate is first added, followed by the milk and lime or casein spreader. The agitator is then started and the lime-sulfur is slowly poured in. Finally, just before starting to spray, the lead arsenate is added.

It is important to follow the above procedure in order to disperse the nicotine sulfate uniformly throughout the mixture. If, for example, the nicotine is added to the lime-sulfur, a stringy coagulated mass of precipitated nicotine is formed which cannot be dispersed by the movement of the agitator.

Nicotine sulfate—lime-sulfur. The same procedure should be followed for this combination as for the nicotine sulfate—lime-sulfur—lead arsenate mixtures, except that the lead arsenate is not added. Other precautions regarding the use of milk or casein spreader and the addition of an extra pound of lime should be taken.

Bordeaux mixture—lead arsenate. The bordeaux mixture should be prepared as described previously under "bordeaux mixture," pages 8-9. The lead arsenate is then added just before beginning to spray.

Oil emulsion—lead arsenate. It is perhaps advisable in this combination to make an exception to the general rule "to add the lead arsenate last." On account of the consistency of the oil emulsion it is difficult to disperse quickly and uniformly the lead arsenate throughout the mixture. If, therefore, the lead arsenate is added when the tank is about three-fourths full and then followed by the oil emulsion an excellent, uniform mixture will be obtained.

As stated above, the oil emulsion should be diluted with an equal amount of water before pouring slowly into the tank. This combination spray should be applied immediately after it has been mixed.

Bordeaux—oil emulsion. The bordeaux should be prepared as described previously under "bordeaux mixture," pages 8-9. After the tank is nearly filled with the bordeaux, the oil emulsion is slowly added. As noted above, the oil emulsion should be mixed thoroughly with an equal amount of water before adding to the tank.

Bordeaux—nicotine sulfate. The bordeaux should be prepared carefully as described under "bordeaux mixture," pages 8-9. The required amount of nicotine sulfate is diluted with about a gallon of water and added just before leaving the filling station.

Bordeaux—nicotine sulfate—lead arsenate. This combination should be prepared as outlined under "bordeaux—nicotine sulfate" in the previous paragraph and the lead arsenate added in the orchard just before beginning to spray.

Bordeaux—lime-sulfur. This combination should not be used. The chemical reaction between the two spray materials is so complete that the individuality of both is destroyed. It is questionable whether the reaction products of the combination have any fungicidal or insecticidal value.